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ABSTRACT

The predictors of students' completed and planned enrollments in college level computer courses were examined. A total of 195 college freshman and sophomore students (102 females and 93 males) who were enrolled at a large land-grant university in the southern region of the midwestern United States completed instruments measuring computer attitudes, computer attributions, and selected personal demographics. The Computer Attribution Scale and the Computer Attitude Scale were used. Results of a stepwise multiple regression analysis and simple correlational analyses indicate that perceptions of the usefulness of computers in future educational and career plans, self-evaluation of one's own computer proficiency, failure-task attributions, and the stereotyped view of computers as a male domain combine to function as significant predictors of enrollment in computer courses. The inclusion of the computer attitude of stereotyping computers as a male domain serves to control for irrelevant variance in the criterion variable of enrollment in computer courses. Furthermore, students who do not stereotype computers as a male domain tend to also have the attitude that computers will be useful to them in their education and careers. Two data tables are included. (Author/TJH)

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Self-perceived Computer Proficiency, Computer Attitudes, and Computer Attributions as Predictors of Enrollment in College Computer Courses

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Abstract

The predictors of students' completed and planned enrollments in college level computer courses were examined. A total of 195 college freshman and sophomore students completed instruments measuring computer attitudes, computer attributions, and selected personal demographics. Results of a multiple regression analysis and simple correlational analyses indicate perceptions of the usefulness of computers in future educational and career plans, self-evaluation of one's own computer proficiency, failure-task attributions, and the stereotyped view of computers as a male domain combine to function as significant predictors ($p < .001$) of enrollment in computer courses. The inclusion of the computer attitude of stereotyping computers as a male domain serves to control for irrelevant variance in the criterion variable of enrollment in computer courses. Furthermore, students who do not stereotype computers as a male domain tend to also have the attitude that computers will be useful to them in their education and careers.

Self-perceived Computer Proficiency, Computer Attitudes, and Computer Attributions as Predictors of Enrollment in College Computer Courses

Computer skills have become such a critical need for entry and success in so many different occupational fields in recent years that it appears computer usage has joined mathematics as a new "filter" limiting educational and career choices of students. In fact Loyd and Gressard (1984) report that computers have become such a necessary and integral part of the process of education that curriculum specialists have moved from debating the wisdom of using computers in the classroom to trying to establish the most effective implementation timeline and usage practices for computer use in the classroom. For educators who are interested in motivating students to adequately prepare themselves in computer usage, knowledge of some of the factors impacting the students' decisions regarding whether to engage and persist in the study of computers is vitally important.

Many students are very positive about working with computers and develop a fairly high skill level in computer usage (Loyd & Gressard). However, a number of students appear to view the contacts they have with computers as very unpleasant (Marcoulides, 1988). Prior research (Byrnes & Johnson, 1981; Leader & Klein, 1977; Sherman, 1981) indicates that students may experience emotional reactions that may enhance or slow down, and in some cases even prevent, the development of the ability to effectively use computers.

A student's perception of his/her own competency in a subject area is related to the willingness with which the student will attempt to complete tasks in that area (Reyes, 1984). Therefore, students typically choose school tasks that they are more confident will result in successful achievement.

The causal attributions students make relative to computers is an affective factor having the potential to impact students' motivation to develop computer skills. Causal attributions of academic performance deal with the reasons students give for success or failure at an academic task and have been identified as significant predictors of both persistence and achievement by several researchers (Bar-Tal, 1978; Dweck, Davidson, Nelson, & Enna, 1978). Weiner (1979, 1985, 1986) indicates that the underlying causal dimensions of students' attributions are more important as causes of achievement outcomes than are the specific perceptions of the causes of the achievement outcomes. Stipek (1988) has related Weiner's work to classroom learning and describes the potential of causal attributions for affecting desired learning outcomes in the classroom. Furthermore, Stipek reports that causal attributions or beliefs about the causes of academic performance outcomes are related to the achievement outcomes of both high- and low-performing students.

This relationship may be a function of the emotional consequences of attributions. Atkinson (1964) and Weiner (1980, 1985, 1986) report negative emotions serve as inhibitors of the productive behaviors necessary for increased achievement levels, while positive emotions motivate students to

engage in those productive behaviors.

Computers have traditionally been associated with the mathematics curriculum (Campbell, 1988; Gardner, McEwan, & Curry, 1986), and the use of computers is viewed as a mathematics skill by many students (Marcoulides, 1988; Mohamedali, Messer, & Fletcher, 1987). This has implications for the study of factors affecting students' decisions to enroll in computer courses. In a 1981 study, Pedro, Wolleat, Fennema, and Becker identified selected mathematics attitudes and attributions that have been shown to be logically or statistically related to election of mathematics courses. Based on the findings of their study, the relationships among election of computer courses, self-perceived proficiency in using computers, computer causal attributions, and selected computer attitudes that appear to be important in the decision to elect to take college computer courses were examined in this study. Furthermore, earlier studies have also reported relationships between sex and mathematics attitudes (Block, 1973; Dornbush, 1974; Fennema, 1977; Hilton & Berglund, 1971; Stein & Smithells, 1969) and enrollment in mathematics courses (Pallas & Alexander, 1983; Sherman & Fennema, 1978). Therefore, the bivariate relationships between sex and (a) computer attitudes, (b) computer attributions, and (c) election of computer courses were also examined.

Methods

Subjects

The subjects of this study were 195 (102 females and 93 males)

freshman and sophomore students enrolled in a large land-grant university located in the southern region of the midwestern United States. All of the students were enrolled in a two credit hour career awareness class. The subjects represented five ethnic groups, White (87%), Black (9%), Hispanic (1%), Asian (1%), and American Indian (2%), and approximately 68% of the students had completed one or more semesters of computer coursework. Over 86% of the students reported they had used computers, and of those, 34% had written computer programs. Participation in the study was voluntary, and the subjects were assured that the anonymity of their responses to the instruments used in the study would be protected. The instruments for this study were administered by the students' instructors in the career awareness class.

Analysis

A stepwise multiple regression anlaysis was calculated to identify the computer attribution, computer attitude, and demographic variables that are significant predictors of election of computer courses. Although a number of researchers advise against the use of the stepwise procedure, Stevens (1986) reports that the stepwise procedure is more often recommended by statisticians than other selection procedures when the research focus is to identify from a set of potential predictors those variables which together account for the most variance in the criterion. Pearson correlation coefficients were also calculated to examine the relationships between (a) computer attributions and computer attitudes, (b) computer attributions and selected demographic variables, and (c)

computer attitudes and selected demographic variables.

Instruments

Computer attributions. The Computer Attribution Scale was developed by modifying the Mathematics Attribution Scale (Fennema, Wolleat, & Pedro, 1979) so that all references to mathematics were changed to computers. The Computer Attribution Scale has eight subscales with success and failure events paired with each of four attribution categories proposed in a 2 x 2 model of causal attribution by Weiner (1974).

The four cells in Weiner's model are divided by stability (stable vs. unstable) and locus of control (internal vs. external) dimensions and the attributional categories assigned to the four cells are ability (internal and stable), effort (internal and unstable), task difficulty (external and stable) and environmental (external and unstable). The environmental category originally referred to as luck by Weiner was renamed environmental by Fennema, Wolleat, and Pedro (1979) when they added items focusing on causes related to behaviors of the teacher to the subscale constructed to measure unstable and external attributions.

The Computer Attribution Scale, like the Mathematics Attribution Scale, has eight subscales. Four of the subscales list success events in the use and study of computers as stems and four list failure events. Each of the stems is followed by four attribution statements; each statement represents one of the four attribution categories, ability, effort, task, and environmental. An example of a success event item is:

Event: You have passed most of the tests in the computer course with no trouble.

1. The teacher made learning computers interesting.
2. Like everyone says, you're talented in computers.
3. But, you spent hours of extra time on this class.
4. The units were the beginning group, easy ones.

The students read each event stem and identified on a five-point Likert response scale ranging from strongly agree to strongly disagree, their perceptions of the extent to which each of the four causes really explained the event, assuming it had happened to them. Eight subscale scores were calculated for each student by adding responses across each of the success/failure events paired with the four attribution categories: success-ability, success-effort, success-task, success-environment, failure-ability, failure-effort, failure-task, and failure-environment. Cronbach's alpha estimates of internal reliability range from .37 to .76, with a median of .53. The scales measuring the internal dimensions had the higher reliability coefficients. These estimates are very similar to estimates reported by Fennema et al. (1979) for the Mathematics Attribution Scales.

Computer attitudes scale. The Computer Attitude Scale was developed using four scales, usefulness, effectance motivation, anxiety, and stereotyping of mathematics as a male domain, from the Fennema-Sherman Mathematics Scales (Fennema & Sherman, 1976) as the basis. The four scales from the Fennema-Sherman Mathematics Attitude Scales were modified so that each scale focused on computer attitudes. These four

scales were selected for use in this study because an earlier study (Pedro, Wolleat, Fennema & Becker, 1981) of students' decisions to take mathematics courses identified these attitudes as being important predictors of students' enrollment in mathematics courses.

Each of the four scales has 12 items, and each item is responded to using a five point Likert-type scale ranging from strongly agree to strongly disagree. Half of the items on each scale are written with a positive orientation and half with a negative orientation. The items from the four scales were randomly ordered together to comprise the Computer Attitude Scale for this study. The subscales were scored so that a high score reflects a high level of the attitude measured by the subscale, except for the Computers as a Male Domain subscale. Therefore, high scores on the Computer Anxiety subscale reflect a high level of computer anxiety; high scores on the Computers as a Male Domain subscale indicate a low level of stereotyping computers as a male domain; and high scores on the Usefulness of Computers and Effectance Motivation of Computers subscales indicate positive feelings about the usefulness of computers in relationship to one's own future education and career activities and about the enjoyment and challenge one gains from working with computers, respectively. Each of the subscales yields scores ranging from 12 to 60, and the Cronbach's coefficient alpha reliability estimates of the subscale scores range from .88 to .92. These estimates are slightly higher than those reported for the corresponding mathematics attitudes scales (Fennema & Sherman, 1976).

Personal and educational information were collected with a brief demographic questionnaire. These data include sex, race, college classification, self-perceived level of proficiency using computers, semesters of computer courses completed (including any current enrollment), and semesters of computer courses planned. Sex was coded 1 for female and 2 for male. The number of semesters of computer courses completed and the number of semesters of computer courses each student planned to enroll in before graduating from college were summed to yield a measure of enrollment in computer course. Level of proficiency using computers was measured by student's selection of a response to an item listing five levels of increasing proficiency ranging from "I have no experience with a computer" to "I am proficient in programming in one or more computer languages."

Results

The data pool for this study consists of 15 measures: sex, self-perceived level of proficiency of computer use, enrollment in computer courses, four computer attitudes, and eight computer attributions. Means and standard deviations of responses to the variables are listed in Table 1.

Insert Table 1 about here

The intercorrelations between all pairs of variables, along with the values of correlation coefficients associated with probability levels less than .05 or .01 are reported in Table 2. Because of the high probability of making a

large number of Type I errors when testing for significance of the 105 correlations listed in Table 2, only correlations above .31, indicating a

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Insert Table 2 about here

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minimum of 10% shared variance, were viewed as representing meaningful relationships. A review of the correlation coefficients in Table 2 indicate only 11 out of the 32 correlations calculated between computer attitudes and computer attributions are above .31, and of those 11, six of the coefficients are either equal to or within .02 of the coefficient, .32, used to identify meaningful relationships. The success-effort computer attribution is related to the computer attitudes of usefulness of computers ($r = .33$), effectance motivation of computers ($r = .32$), and computers as a male domain ($r = .33$). Additionally, the computer attribution of success-ability is related to the computer attitudes of effectance motivation of computers, ($r = .47$) and computer anxiety ($r = -.39$). The attribution of success-environment is correlated ($r = .36$) with only one of the computer attitude measures, computers as a male domain, while the failure-ability computer attribution is related to computer anxiety ($r = .61$), effectance motivation of computers ($r = -.52$) and usefulness of computers ($r = -.33$). Weak relationships between the failure-task attribution and the computer attitudes of effectance motivation on computers ($r = -.32$) and computer anxiety ($r = .34$) were also calculated. The only meaningful correlation calculated between computer attributions and (a) computer proficiency, (b)

enrollment in computer courses, and (c) sex is the correlation between enrollment in computer courses and the failure-ability attribution ($r = -.34$). The correlations between enrollment in computer courses and (a) perceptions of computer usefulness ($r = .44$), (b) effectance motivation of computers ($r = .39$), and (c) computer anxiety ($r = -.39$) and between sex and computers viewed as a male domain ($r = -.37$) appear to reflect relationships that, although weak, are also worthy of interpretation.

Computer course enrollment was regressed on computer proficiency, the four computer attitude variables, and the eight computer attribution variables using the SPSS-X Regression procedure (SPSS-X Inc., 1986). The 13 independent variables were entered using the stepwise selection method. The independent variables that contribute significantly ($p < .05$) to the multiple R are entered so that the order of entry of predictors is such that the first variable to enter is the one with the largest correlation with the dependent variable, the second variable that enters the equation is the one with the largest semipartial correlation, etc.

A summary of the stepwise multiple regression analysis of election of computer courses is presented in Table 3. The predictor variables that contributed significantly to the multiple R are listed in order of entrance into the equation. An F-ratio was calculated for the contribution of each variable to the multiple R, and the level of significance associated with that contribution is indicated for each multiple R. The independent variables that did not contribute significantly to the prediction of election of computer courses are not listed in the summary table.

Insert Table 3 about here

The data listed in Table 3 indicate students' perceptions of the usefulness of computers in their education and career plans is the most influential variable for prediction of enrollment in computer courses. Perceptions of usefulness of computers accounts for 19% of the variance in enrollment in computer courses. Additional variance in students' enrollment in computer courses was explained by students' self-evaluation of their own computer proficiency (12%), failure-task attributions (4%), and perceptions of computers as a male domain (2%), resulting in 37% of the variance in semesters of enrollment in computer courses being accounted for. The results of this analysis further indicate perceptions of computers as a male domain is functioning as a suppressor variable (Pedhazur, 1982) since perceptions of computers as a male domain has a correlation close to 0 ($r = .04$) with enrollment in computer courses, but is more highly correlated ($r = .48$) with the students' perceptions of the usefulness of computers in their education and career plans. Therefore, inclusion of perceptions of computers as a male domain controls irrelevant variance in the analysis.

Discussion

Only a few of the computer attitude, computer attribution, and demographic variables investigated in this study appear to be useful in explaining the variation in the number of semesters of computer

coursework elected by students. This is probably due to a large extent to the intercorrelations among the predictor variables. Computer attitudes were highly intercorrelated, while many of the computer attributions were moderately to strongly interrelated and also moderately related to two of the four measures of computer attitudes.

A review of the simple correlations calculated between enrollment in computer courses and the 14 predictor variables reveals that using the subset of those variables identified as significant predictors in the multiple regression analysis dramatically increases the proportion of variance accounted for in semesters of computer coursework completed and planned. Students' perceptions of the usefulness of computers has the strongest relationship to their enrollments in computer courses. The students' self-evaluation of their computer proficiency, their failure-task computer attributions, and perceptions of computers as a male domain also contribute significantly, but to an increasingly lesser extent, to the prediction of students' enrollments in computer courses.

The college students in this study were more likely to elect to enroll in more semesters of computer courses if they perceived computers were of value in their future educational and career plans. Furthermore, students who believed themselves to be relatively more proficient in the use of computers and who did not attribute their failures in the use of computers to the task involved were more likely to elect to take more computer courses. These three variables and the suppressor variable of perceptions of computers as a male domain accounted for a total of 37% of

the variance in election of semesters of computer courses by college students.

Similar to the findings in the study of persistence in the study of mathematics by Pedro, Wolleat, Fennema, and Becker (1981), this study found students' perceptions of the usefulness of computers in their future lives was the best predictor of enrollment in computer courses. This result underscores the critical need of making secondary and college students aware of computers and providing those students with opportunities to develop an appreciation of how knowledge of computers will be of value as they make educational choices and consider career options. Also, giving those same students opportunities to have successful experiences using computers and to develop computer skills may further contribute to their decisions to enroll in computer courses. To a somewhat lesser extent, it is important to teach students to make realistic attributions about their failures in the use of computers. Educators should encourage students to not stereotype computers as an area of serious study in which males can be more successful than females. The failure to stereotype computers as a male domain may encourage both more female students to engage in the study of computers and more male students to accept females as equals in computer classes.

The correlations calculated between computer attributions and computer attitudes indicate that these two constructs are for the most part not highly related. This finding was not surprising since emotions, the affective component of attitudes (Gage & Berliner, 1984; Klausmeier,

1985), have been found to be unrelated to a subject's causal attributions for a specific outcome (Weiner, Russell & Lerman, 1978, 1979). However, positive computer attitudes do have important practical implications for learning motivation because according to Gage and Berliner (1984), "Attitudes. . . arouse and direct purposeful activity" (p. 376). If students enjoy the challenge of computers, realize the usefulness and/or value of computers in their education and career plans, experience low levels of computer anxiety, and do not perceive computers as a sex stereotyped field, they are more likely to derive pleasure out of working with computers. In fact, the findings of this study indicate enrollment in computer courses is related to a linear combination of measures of all of these variables. Interestingly, the relationship between sex and the perception of computers as a male domain indicates females tend to view computers as less of a male domain than do males, although sex accounts for a very small (14%) amount of variance in perceptions of computers as a male stereotyped field.

The information provided in this study needs to be cross-validated, and should therefore be interpreted with caution. However, even without the needed cross-validation research it can be asserted that educational interventions planned by educators and based in an understanding of the predictors of students' enrollments in computer courses have the potential to provide students with more flexibility in their educational and career choices than if they are prevented from entering scientific and technical occupations due to inadequate preparation in use of computers.

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Table 1

Means and Standard Deviations for All Variables

N = 192[a]

Variables	M	SD
(1) Computer Proficiency[b]	3.03	1.09
(2) Enrollment in Computer Courses[c]	2.66	1.00
(3) Usefulness of Computers	45.81	8.01
(4) Effectance Motivation of Computers	38.66	8.66
(5) Computer Anxiety	32.12	8.21
(6) Computers as a Male Domain	50.00	6.74
(7) Success-Effort	14.74	2.69
(8) Success-Ability	12.56	2.64
(9) Success-Environment	15.18	1.96
(10) Success-Task	13.72	2.15
(11) Failure-Effort	14.12	2.54
(12) Failure-Ability	12.90	2.51
(13) Failure-Environment	11.58	2.30
(14) Failure-Task	13.94	2.15

a Females, n = 105. Males, n = 87.

b Self-report of computer proficiency on a five-point scale ranging from 1 (never used a computer) to 5 (proficient in one or more computer languages).

c Sum of number of semesters of computer courses completed and planned before college graduation.

Table 2

Correlations[a] Between Pairs of Variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(1) Computer Proficiency[b]		+3	24	23	29	29	06	17	05	02	-05	-22	-05	-14	11
(2) Enrollment in Computer Courses[c]			44	39	-39	04	11	25	-12	-11	-13	-34	-10	-29	-01
(3) Usefulness of Computers				52	-46	-45	33	31	08	-04	-07	-33	-26	-11	-06
(4) Effectance Motivation of Computers					-73	18	32	47	02	-08	-08	-52	-06	-32	08
(5) Computer Anxiety						-18	-09	-39	-01	-03	09	61	03	34	-09
(6) Computers as a Male Domain							33	13	16	14	12	00	-23	17	-37
(7) Success-Effort								28	27	06	01	-04	-06	07	-28
(8) Success-Ability									07	01	-[illegible]	-42	04	-15	18
(9) Success-Environment										31	17	16	-01	31	-21
(10) Success-Task											25	26	14	30	02
(11) Failure-Effort												20	02	23	01
(12) Failure-Ability													13	48	-11
(13) Failure-Environment														18	06
(14) Failure-Task															-05
(15) Sex[d]															

a Decimal points preceeding the correlation coefficients are omitted.
N = 195, $p < .05 = .14$; $p < .01 = .18$.

b Self-report of computer proficiency on a five-point scale ranging from 1 (never used a computer) to 5 (proficient in one or more programming languages).

c Sum of number of semesters of computer courses completed and number of semesters of enrollment in computer courses planned before college graduation.

d Sex is coded 1 for female, 2 for male.